Astronomy 830, Autumn 2004, Problem Set 3

Due Friday, October 15 in class

Problem 1:

A K5III star is observed in the direction of a molecular cloud. The observed magnitudes in the B, V, J, and K bands are as follows:

B=20.45, V=16.98, J=7.48, K=4.56

The measurement uncertainties are 0.02^{mag}.

a) What are the intrinsic (B-V), (V-K), and (J-K) colors for an unreddened K5III star? Please cite your source.

b) What are the observed (B-V), (V-K), and (J-K) colors, and the color excesses E(B-V), E(V-K), and E(J-K) for this star, and their associated uncertainties?

c) Estimate of the total visual extinction, A_v, and the ratio of total to selective extinction, R_V, towards this star. This is an example of how stellar colors are used to *measure* R_V instead of just adopting some standard value.

d) What is the distance to the star estimated from its apparent/absolute brightness and derived reddening? You are given that the distance to the molecular cloud is 180pc, and that it is about 1-2pc thick. Where is the star located with respect to the molecular cloud?

e) Now consider what would happen if you had instead misclassified the star as a K5v *dwarf* (i.e., same spectral type but different luminosity class). Discuss quantitatively how your conclusions about the location of the star would have changed. For this distance and the estimated extinction (A_V), what would you conclude about the total gas column to the star? Is this a sensible number?

Problem 2:

The pulsation period P for p-modes excited by the κ-Mechanism is of order the sound-crossing time of the star:

$$P \approx \left(G\bar{\rho}\right)^{-1/2}$$

$\bar{\rho}$ is the mean density of the star.

a) For stars more massive than ~$0.4M_\odot$, we found that the empirical mass-luminosity relation predicts $L \propto M^4$. Show that at fixed effective temperature these stars should have a Period-Luminosity relation of the form:

$$P \propto L^{5/8}$$

b) Estimate the characteristic pulsation periods of fundamental p-modes for the Sun and a supergiant star with 5 $M_\odot$ and the same T_{eff} as the Sun. You may assume that $L \sim M^4$ for main-sequence stars still holds (it does: massive stars evolve off the main sequence at nearly constant L).